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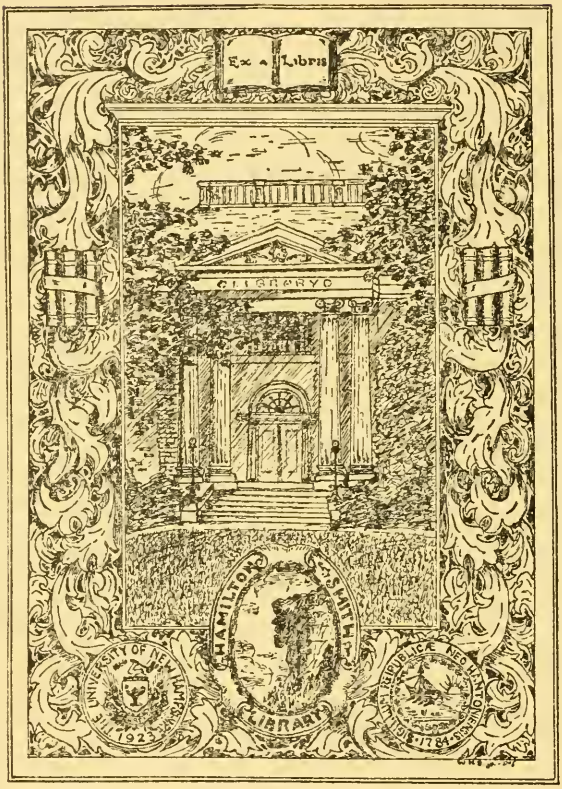

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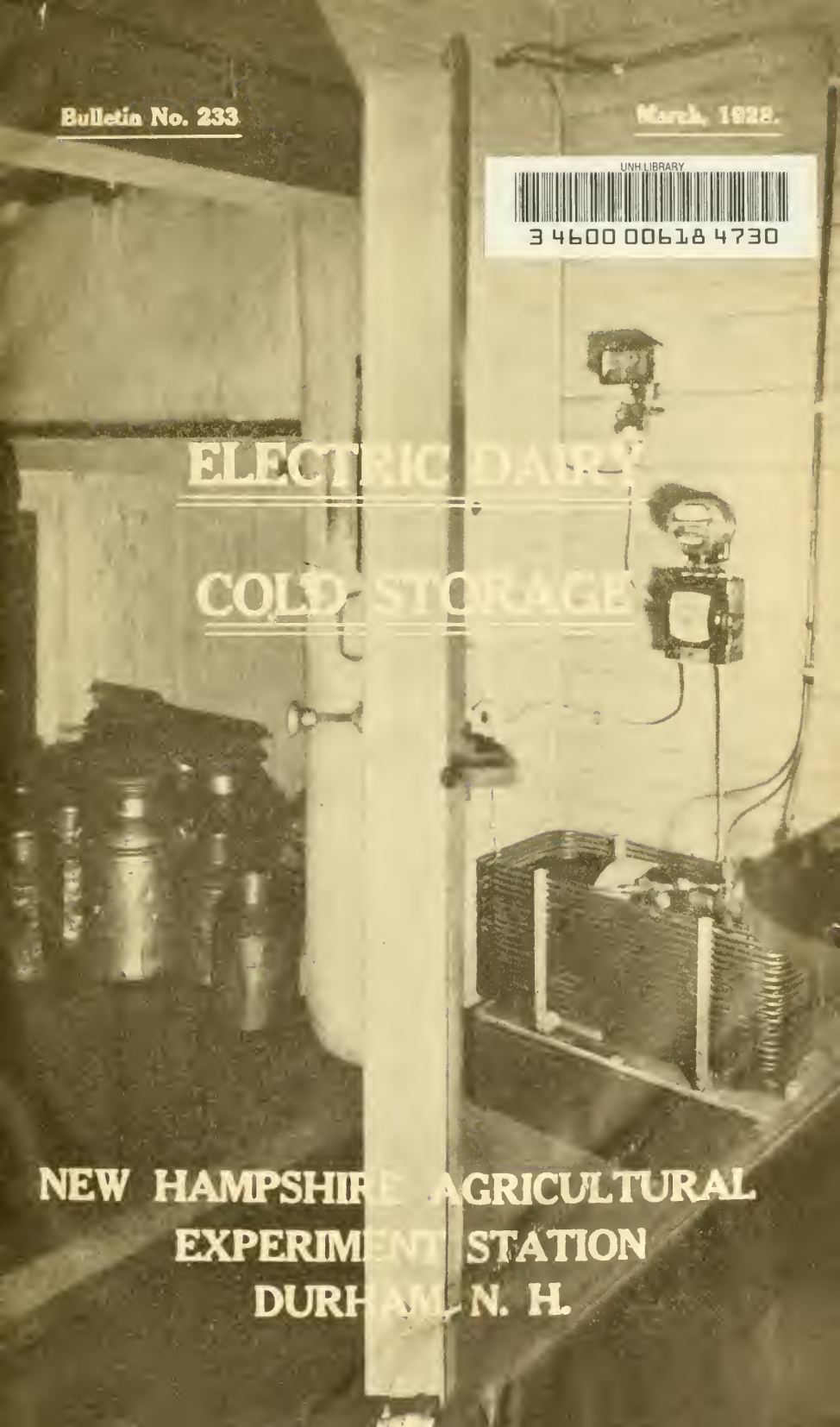

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NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION
DURHAM, N. H.

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POTATO PRODUCTION COSTS IN NEW HAMPSHIRE

By M. F. ABELL

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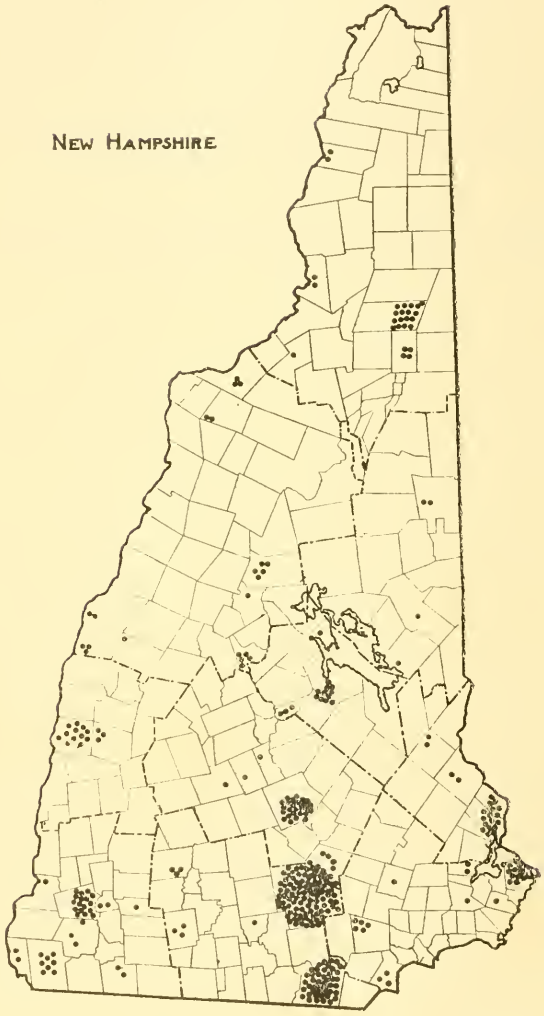

Figure 1—Map showing carloads of potatoes purchased from other than local farmers by stores, hotels and camps from October to May. (One dot equivalent to one carload.)

POTATO PRODUCTION COSTS IN NEW HAMPSHIRE

By M. F. Abell

The state-wide survey conducted by the Experiment Station in 1925 disclosed that 57 per cent. of the potatoes handled by hotels, stores and camps were procured from outside of New Hampshire.[1] This situation pointed to the need for a study of the costs and methods of potato production on New Hampshire farms.

The area in potatoes in the state has rapidly declined since 1909, although total production has been nearly maintained. The area and production of potatoes and the December first farm price for New Hampshire, and the December first farm price for the United States for 30 years are shown in Table I. From a high point in area in 1909 the decline has been regular and consistent except for the three war years, 1917, 1918 and 1919. In only one year, however, 1910, has the average farm price in New Hampshire been less than in the United States as a whole, and this was a year of high production, the highest ever had in New Hampshire, and the fourth highest for the northeast.

On the other hand, in New England as a whole, approximately 50 per cent. has been added to the total production in the last 25 years and 10 per cent. to the area devoted to potatoes. In 1904 New England had 207,000 acres and a production of 33,424,000 bushels. In 1928 a total of 239,000 acres produced 45,662,000 bushels. In northeastern United States (New England plus New York and Pennsylvania) 900,000 acres in 1904 produced 102 million bushels, while 769,000 acres in 1928 produced 101 million bushels.

The reduction in area in New Hampshire is an attempt at readjustment resulting from a variety of causes. The area in farms has decreased reducing the tillable area. The larger area in potatoes in other regions has partly taken care of the greater demands of increased population. Better methods have so improved yields that the smaller area in New Hampshire has produced nearly as large a total yield. Lower prices following the war removed much of the incentive to produce a crop involving so much labor and risk. The competition with machine raised potatoes of nearby regions has meant greater marketing difficulties with poorer graded potatoes in less than carlots from smaller growers.

The smaller area in New Hampshire, even with the total yield remaining practically the same, has not, however, kept pace with population, and the yield per 1,000 of population has been approximately cut in half. Table II shows how this situation varies among the ten counties.

While formerly a surplus state, New Hampshire as a whole is now a deficit area, and imports large quantities of potatoes from Maine. In 1923 a total of 412 carloads was shipped into New Hampshire. There has since been only a slight change. For the

TABLE I

Area, Total Yield and Dec. 1 Price per Bushel for Potatoes in New Hampshire, and Dec. 1 Price per Bushel for U. S. from 1899 to 1928, Inclusive. (a)

Year	Potato Acreage in New Hampshire	Yield	New Hampshire Dec. 1 Price	United States Dec. 1 Price
	Acres	Bus.	Cents	Cents
1899	18,662	2,370,074	46	39
1900	17,916	1,809,516	53	43
1901 (b)	18,284	1,974,672	79	77
1902	18,650	2,238,000	69	47
1903	18,277	1,791,146	65	61
1904	19,922	2,689,470	56	45
1905	19,723	2,366,760	72	62
1906	19,329	2,164,848	60	51
1907	19,000	2,280,000	67	62
1908	19,000	1,900,000	73	71
1909	21,000	2,730,000	64	55
1910	21,000	3,150,000	52	56*
1911	17,000	2,125,000	87	80
1912	17,000	2,380,000	61	51
1913	17,000	2,074,000	83	69
1914	17,000	2,703,000	60	49
1915	16,000	1,520,000	95	62
1916	15,000	1,800,000	166	146
1917	21,000	2,247,000	167	123
1918	21,000	2,940,000	145	119
1919	20,000	2,400,000	175	160
1920	15,000	1,905,000	155	115
1921	14,000	2,240,000	135	110
1922	14,000	1,400,000	105	58
1923	13,000	2,470,000	115	82
1924	11,000	1,870,000	84	63
1925	11,000	1,595,000	235	187
1926	11,000	1,815,000	170	141
1927	12,000	1,800,000	140	96
1928	12,000	1,656,000	85	58

(a) Yearbooks U. S. D. A.— 1900-1927
(b) Bureau of Statistics Bul. 62, U. S. D. A.

year 1925 this is strikingly shown in Table III and Figure I.[1] With a total production in the state of 1,595,000 bushels, 412 cars represent one-fifth of New Hampshire's production.

Studies were made of the cost of producing potatoes under the various conditions that obtain near our large consuming markets, and of the methods and practices that better enable our farmers more nearly to meet local consumption demands.

Definite information was obtained on quantitative units of labor and materials, total cost, and the most profitable and economical methods of producing the potatoes required by our markets.

TABLE II

Total Area and Production per Acre and per Thousand of Population by Counties for 1900, 1910, 1920 and 1925. (a)

County	Year	Area	Yield per Acre	Yield per 1000 Pop.	Per cent. of Tillable Area
		Acres	Bus.	Bus.	
Belknap	1900	1,191	125	7,611	--
	1910	1,154	139	7,529	--
	1920	841	104	4,121	--
	1925	749	148	— —	2.2
Cheshire	1900	1,413	113	5,113	--
	1910	1,196	126	4,935	--
	1920	1,011	87	2,872	--
	1925	610	128	— —	1.5
Coos	1900	2,554	188	16,264	--
	1910	2,502	183	14,855	--
	1920	1,647	133	6,089	--
	1925	1,274	185	-- —	2.3
Grafton	1900	2,944	136	9,841	--
	1910	2,802	149	10,052	--
	1920	2,064	113	5,750	--
	1925	1,409	134	— —	1.5
Hillsboro	1900	2,067	114	2,100	--
	1910	1,644	125	1,626	--
	1920	1,333	90	886	--
	1925	1,031	110	— —	1.4
Merrimack	1900	2,446	107	5,000	--
	1910	2,113	125	4,972	--
	1920	1,491	102	2,947	--
	1925	1,277	122	— —	1.8
Rockingham	1900	2,625	104	5,346	--
	1910	2,259	108	4,678	--
	1920	1,848	94	3,306	--
	1925	1,605	120	— —	2.3
Strafford	1900	1,647	107	4,484	--
	1910	1,377	112	3,943	--
	1920	916	73	1,730	--
	1925	675	125	— —	1.8
Sullivan	1900	1,085	116	7,020	--
	1910	1,106	144	8,273	--
	1920	989	89	4,142	--
	1925	619	144	— —	1.6

(a) U. S. Census 1900, 1910, 1920, 1925.

Method

The data for the study were collected by a survey of nearly 200 farms in 1926 and 1927 and from detailed labor records of twelve farms. An attempt was made to visit all so-called commercial growers raising two acres or more. About 10 per cent. of the potatoes raised in the state are represented.

For certain of the data the state was divided for study into two sections. Coos and Grafton Counties represented the surplus

area. The balance of the state was called a deficit region. To gather other data the state was divided into three areas. Area I, Coos and Grafton Counties, is the surplus region; Area II, Merrimack and Rockingham Counties is a deficit region in the vicinity of larger markets; and Area III which includes scattered growers supplying local markets in the balance of the state. In part of the tables, wherever accuracy would not be sacrificed, averages of data for both years of the survey have been used to give a better picture of usual conditions.

TABLE III

Potatoes—Purchases from Retail Stores, Hotels and Camps, from Farmers and from Others.

District	Potatoes (bushels)				
	From farmers	From others			
		Total	June and July	Aug. and Sept.	Oct. to May
1. Upper Coos	21,150	18,630	2,830	470	15,330
2. White Mt.	26,340	14,050	3,890	2,410	7,750
3. Lake Region	32,890	62,720	23,960	14,000	24,760
4. Sullivan	29,280	24,700	7,610	1,900	15,190
5. Cheshire	14,050	47,840	14,790	3,770	29,280
6. Merrimack Valley	75,660	221,430	57,700	31,160	132,570
7. Coast	24,190	46,090	20,440	5,510	20,140
Total	223,560	435,460	131,220	59,220	245,020

Climate

The northern part of the state is more favorably located than the southern part for the production of large yields. Both latitude and altitude effect a cooler growing season favorable for larger yields. In 1926 rainfall was conducive to a large crop. In 1927 rainfall was too heavy and yields were somewhat lower.

The southern part of the state suffered from lack of rainfall in 1926 and yields for the most part were low. In 1927 more than the usual amount of rain increased yields but also fostered diseases.

The twenty-five year average rainfall for the five months, May to September inclusive, at Durham is 17.03 inches. In 1926 about half this amount or 8.95 inches was recorded. In 1927 nearly double the normal amount, 30.95 inches, fell. This was nearly four times the 1926 rainfall.

This amount of rainfall at Durham was typical of the southern part of the state for the crop years 1926 and 1927 and for the average, and had a marked influence on yield of potatoes.

The importance of the relation of rainfall to yield is shown by a study made by the New England Crop Reporting Service.[2] The five low rainfall years were years of higher yields than the five high rainfall years. However, certain restricted areas may have so little rainfall as to reduce the yield. This occurred in southern New Hampshire in 1926.

Topography and Soil

Since much of the labor saving in potato growing depends on the use of machinery, the topography of the area has an important relation to labor requirements. Some fields were too steep or too rocky to use machinery to the best advantage, and the saving in labor when used was small as compared to level fields without rocks. Where the topography is thought to be unsuited for machinery, much of the planting and most of the digging were done by hand.

There is also a prejudice against the use of machines in certain areas. Machines poorly adapted for a wide variety of conditions, frequent unsatisfactory use in weedy and grassy fields, and local custom in regions where it is easier to get good men to dig by hand, are partly responsible.

TABLE IV.

Relation of Soil to Yield, Labor per Acre and Labor and Cost per Bushel. 1926-1927.

Area	Soil	Number of Farms	Area in Potatoes	Yield per Acre	Man Labor per Acre	Man Labor per Bushel	Cost per Bushel
I	Fair	27	5.1	231.7	165.5	.71	.70
	Good	32	5.8	279.9	151.7	.54	.58
	Very Good	44	5.6	304.1	115.7	.38	.51
II	Fair	18	4.9	172.5	122.9	.71	.97
	Good	43	4.8	174.0	111.3	.64	.92
	Very Good	23	6.2	232.7	124.9	.54	.74
III	Fair	21	5.6	138.6	111.1	.80	1.08
	Good	38	4.6	191.5	127.6	.67	.90
	Very Good	17	5.9	256.6	106.2	.41	.61

This attitude is probably more noticeable in Coos County than elsewhere in the state. There were very few fields which were so steep or rocky as to prevent the use of both planters and diggers. Yet of 64 farmers in Coos County only three used diggers in 1926. All but eleven used planters, however. The inadequacy of the methods of the Coos area to meet competition will be shown in later tables.

It is shown in Table IV that a poorer soil whether rocky, too heavy, too wet, or too hilly, produced a smaller yield, with a higher per acre and per bushel labor requirement, and a higher cost per bushel. Witch grass has the same effect.

The surplus area of the north with its more favorable environment produces higher acre yields than the deficit area of the south, this helping to offset the higher transportation cost to market. The higher prices obtained in deficit areas permit continued production at lower yields, but to warrant continued production these lower yields must be accompanied in many instances by more efficient

TABLE V.

Relation of Size to Labor and Costs per Acre and per Bushel. 1926-1927.

Area	Size Group	Number of Farms	Area in Potatoes	Yield per Acre	Seed per Acre	Fertilizer per Acre	Man Labor per Acre	Man Labor per Bushel	Cost per Bushel
I	Under 3 A.	23	2.1	257.	16.0	1599	156.8	.61	.62
	3 - 5.9	36	3.8	280.	15.3	1695	133.3	.48	.56
	6 - 10.9	24	8.2	293.	15.6	1714	120.5	.41	.52
	11 and over	18	19.3	304.	16.0	1727	84.3	.28	.48
II	Under 3 A.	14	2.0	148.	14.7	1509	125.0	.84	1.18
	3 - 5.9	19	3.8	202.	15.1	1285	128.0	.63	.85
	6 - 10.9	26	7.6	245.	14.9	1459	115.0	.47	.66
	11 and over	14	15.6	203.	14.8	1439	88.0	.43	.70
III	Under 3 A.	24	1.7	178,	15.1	1694	156.5	.88	1.09
	3 - 5.9	25	3.8	176.	14.2	1640	123.3	.70	.97
	6 - 10.9	13	7.3	182.	14.8	1576	102.8	.56	.90
	11 and over	7	21.0	209.	14.8	1699	84.8	.41	.67

methods. Certain farmers have organized their production methods to compete successfully with the efficient growers of other regions on the basis of labor and material requirements.

Other studies have shown that the most important factors influencing potato acre yields are the amount of seed used per acre, the amount and value of manure and fertilizer used per acre, and the frequency of spraying. Certified seed has recently become important. These influences on yield are a factor in their relation to material and labor requirements and to costs per bushel. In addition, differences in area in potatoes have shown some influence on yield, and on labor cost per bushel. Its greatest influence has been on labor per acre largely through the savings in labor made possible with special potato machinery. This acre labor requirement has been reflected in marked decreases in costs per bushel even where yield has remained the same.

In this study the limited data in the tables indicate the influence of one factor compared with another. Otherwise, notes have been made in the table explanation.

Area in Potatoes

One important factor influencing cost of production is the area in potatoes. The larger areas not only require more machinery but must use it more efficiently to accomplish the work in the proper season; even though the larger area on a farm may consist of several small fields. The small grower has the same planting and harvesting time as the larger grower, which permits him to dally with the operations. He quite frequently takes as long to plant and dig as the larger grower.

TABLE VI.

Relation of Distance from Market to Labor and Cost per Acre and per Bushel. 1926-1927.

Area	Distance to Market	Number of Farms	Area in Potatoes	Yield per Acre	Land Rent Per Acre	Labor Per Acre	Labor Per Bushel	Marketing Labor		
								Per Acre	Per Bushel	Cost Per Bushel
I	Under 4 miles	23	8.1	283.4	6.73	105.6	.37	15.7	.05	.66
	4-7 miles	50	4.7	269.0	6.62	115.1	.43	19.3	.07	.61
	Over 7 miles	22	6.3	289.5	5.72	134.4	.46	26.5	.09	.58
II	Under 4 miles	22	5.6	189.2	6.86	106.6	.56	6.3	.03	.93
	4-7 miles	25	3.9	195.8	6.33	121.7	.62	10.7	.05	.91
	Over 7 miles	29	5.5	193.6	5.53	122.6	.63	11.2	.06	.87
III	Under 4 miles	18	3.9	170.8	6.60	104.0	.65	9.7	.06	1.03
	4-7 miles	23	4.6	187.0	5.91	115.0	.63	10.9	.06	.90
	Over 7 miles	28	3.2	192.7	5.31	128.0	.58	15.2	.07	.81

This influence of size is felt in several other ways than in labor required. (See Table V.)

While yield per acre on some of our farms is important because of the limited amount of suitable land available for potatoes, most growers can better afford to use a larger area to obtain the greater total yield, and do it at a much less cost per bushel in labor and money than is possible on the smaller area. Where it is possible to reduce the labor cost per bushel nearly a half by increasing the area from two to eight acres it is advisable to get a larger total yield by expanding rather than by using more fertilizer, seed, and other elements of production.

Decreases in labor of 24 hours, i. e., from 157 to 133 hours, per acre and of 7.2 minutes, i. e., from 36 to 28.8 minutes, per bushel, have been made in Coos and Grafton Counties on an average by increasing the area from 2.1 to 3.8 acres. These changes in area were accompanied by the use of more machinery and more efficient methods.

In the southern part of the state decreases in man labor of 33 hours, i. e., from 156 to 123 hours, per acre, and 10.8 minutes, i. e., from 52.8 to 42 minutes, per bushel in the other counties for 1.7 acres and 3.8 acres respectively are comparable to decreases in the north. In Merrimack and Rockingham Counties labor cost per acre remains the same but, because of differences in yield, labor is reduced 12.6 minutes, i. e., from 50.4 to 37.8 minutes per bushel.

A further increase in area to approximately 7.5 acres decreased labor about 10 per cent.

This reduction in labor per bushel is reflected in a lower cost per bushel. Large decreases in cost per bushel resulted in every case except one as the acreage was increased. In the group of

largest growers in Merrimack and Rockingham Counties there is a slight increase in cost per bushel due to lower yields. Twenty bushels increase in yield in this group would have brought the cost to 63 cents per bushel. Unfavorable weather in the southern part of the state in both years of the survey resulted in some very poor yields.

Land Values

The estimate of land value very often is not based wholly on productive value. In this study the ability of the land to produce potatoes was the chief measure of values.

The soils used for potatoes in this state are so variable that value of land has little significance. On the most suitable soils the yields are better and labor and cost per bushel are much less than on the less favorable soils. (See Table IV.) Many of the better potato soils, however, were located on hills at a greater distance from market. Better soil accounts for the somewhat higher yields on the lower valued land. (See Table VI.) Land values, therefore, seem to be a minor factor in potato production costs within the limits of the values of this study, but quality of soil is still important.

The difference between such extremes as $50 and $150 land seems large, but at 8% the rental cost is $4 in the first case and $12 in the second. The $150 value is no real measure of the ability of land to produce potatoes. Its value may be due largely to location. Only 1⅓ cents per bushel on a 300 bushel crop may be charged against $50 land, while the same yield on $150 land costs only four cents per bushel for rent. Many localities in New Hampshire having excellent potato soils have low land values because of relatively poor scenery.

The distribution of soils adaptable for potato raising and the area suitable for potato production are shown in Table VII. There is still a large area of soil best suited for potatoes on the farms surveyed. This is particularly true in the north. In many cases the potato enterprise appears to be incidental to the dairy business, and, therefore, a larger proportion of the best soils are still available. The potato crop of the state is raised largely on the less favorable soils.

In Coos County 48 per cent. of the total available suitable soil may be classed as very good, 30 per cent. as good soil, and 20 per cent. as only fair soil. In Rockingham County 15 per cent. of the available area is very good soil, 72 per cent. is good soil, and 12 per cent. is only fair soil.

The southern counties are more nearly raising potatoes as a main enterprise using only the better soils. This is necessarily true since only on the better soils can the southern counties compete with the more favorable regions of the north in respect to yield.

Coos County is producing potatoes on a smaller proportion of both its suitable potato area and its total tillable area.

TABLE VII.

Kind of Soil and Suitable Potato Area on Farms in Survey by Counties.

County	Fair		Good		Very Good					
	Number of Farms	Available Crop Area Suitable For Potatoes	Number of Farms	Available Crop Area Suitable For Potatoes	Number of Farms	Available Crop Area Suitable For Potatoes	Total Number of Farms	Available Total Crop Area Suitable for Potatoes	Area in Potatoes	% Potato Area is of Crop Area Suitable for Potatoes
Coos	16	645	26	1175	27	1465	69	3283	406	11.0
Grafton ...	..	...	4	160	6	353	10	513	106	17.1
Merrimack	2	116	13	462	10	440	25	1018	168	14.1
Rockingham	4	115	19	716	3	156	26	987	184	15.7
Belknap ...	1	40	6	205	1	70	8	315	78	19.8
Cheshire ..	..	...	2	75	2	60	4	135	27	16.7
Hillsboro ..	..	...	4	130	..	....	4	130	32	19.8
Strafford ..	10	342	13	399	1	30	24	771	158	17.0
Sullivan ...	..	...	2	45	4	117	6	162	22	12.0
Total ...	33	1258	89	3367	54	2491	176	7314	1181	13.9

Rotation

Hardenburg[3] and Fox[4] in New York found that yield lowered as the length of the rotation increased, but because of the small differences in yield the decreases were not significant. Better tillage practices, or a slight increase in seed or fertilizer, might well account for the increases on the shorter rotations. In New Hampshire the smaller amount of residual organic matter left by the long rotations is largely replaced by regular applications of manure for potatoes. It is true, however, that the more frequent tillage in the shorter rotations tends to keep down insects and weeds which are partly responsible for the increases in labor per bushel in the longer rotations. (See Table VIII.) From the standpoint of labor per acre and per bushel the shorter rotations are desirable.

There are insufficient data from the survey to prove the value of a clover sod in increasing yield of potatoes. The evidence, however, does show that labor per acre and per bushel is consistently less on the short rotations than on the longer rotations. Shorter rotations proved more profitable even though cost per bushel remained practically constant. A saving in labor of 20 to 30 hours per acre in the shorter rotations is one of sufficient importance to consider in the potato organization.

Date of Planting

The short season in Coos County necessitates planting in the spring as early as the season will allow to give the crop time to mature early enough in the fall to permit digging of the entire crop without danger of frost injury. In the southern part of the state early planting often brings the setting of the crop in hot August

TABLE VIII.

Relation of Length of Rotation to Yield, to Labor and Costs per Acre and per Bushel. 1926-1927.

Length of Rotation	Number of Farms	Area in Potatoes	Yield Per Acre	Man Hours Per Acre	Man Hours Per Bushel	Cost Per Bushel
Years						
1-4	46	5.2	231.1	107.1	.46	.68
5	43	5.9	235.3	112.6	.48	.68
6	59	6.2	239.0	127.9	.54	.68
7	71	6.8	237.0	133.4	.56	.68
8+	33	5.6	205.6	136.9	.66	.81

which frequently results in a lowered yield. Too late planting is objectionable because vines grow slowly in hot weather. Occasionally early planting in a wet year will allow a crop sufficient time to mature before serious damage may be caused by late blight. Such seasons are rare and, rather than trust to chance, a somewhat later planting and protection by spraying will ordinarily produce a crop enough larger to more than pay material and labor costs for spraying. (See Table IX.)

One of the facts shown by these data is that higher labor requirement, and higher cost per bushel are incurred with late planted potatoes, even, in some cases, with increased yields.

In 1926 and 1927 in Coos and Grafton Counties a lowered yield resulted from late planting. In Merrimack and Rockingham Coun-

TABLE IX.

Relation of Date of Planting to Yield, Labor and Costs per Acre and per Bushel. 1926-1927.

Area	Date of Planting	Number of Farms	Area in Potatoes	Yield Per Acre	Man Hours Per Acre	Man Hours Per Bushel	Cost Per Bushel
I	May 10-25	37	5.4	295.0	113.5	.42	.54
	May 26-31	33	5.6	279.6	128.7	.46	.57
	June 1+	31	4.6	266.9	129.2	.48	.63
II	May 1-20	35	5.9	205.7	103.7	.50	.78
	May 21-26	30	6.8	191.9	110.3	.57	.84
	May 27+	21	4.9	168.9	127.2	.75	1.02
III	May 1-20	30	6.2	160.4	106.7	.66	.97
	May 21-31	37	6.0	211.8	119.9	.57	.79
	June 1+	31	5.7	184.1	141.5	.77	.98

TABLE X.

Influence on Yield and Labor of Amount of Seed Used per Acre.

Area	Seed Group Limits	Number of Farms	Area in Potatoes	Average Amount of Seed Per Acre	Yield Per Acre	Man Labor Per Acre	Man Labor Per Bushel	Cost Per Bushel
1926								
Coos and Grafton	Under 13.9	8	6.7	13.1	278.8	108.3	.38	.54
	14-14.9	7	4.2	14.2	231.5	120.0	.52	.59
	15-15.9	21	4.0	15.0	271.0	145.0	.54	.53
	16-16.9	16	3.0	16.2	285.7	163.4	.57	.50
	17 and over	6	4.8	18.2	306.4	141.1	.46	.48
Other Counties	Under 13.9	17	7.7	12.7	173.3	91.9	.53	1.03
	14-14.9	7	4.6	14.1	177.6	112.1	.63	.92
	15-15.9	11	8.6	15.1	183.4	101.4	.55	.83
	16-16.9	7	4.3	16.2	219.2	120.0	.55	.77
	17 and over	11	5.0	17.6	226.2	96.0	.42	.73
1927								
I	Under 13.9	7	5.4	13.3	301.0	123.4	.41	.52
	14-14.9	15	5.6	15.0	280.0	120.4	.43	.57
	15-15.9	12	5.5	16.0	305.0	122.0	.40	.53
	16+	15	5.6	18.9	285.0	108.3	.38	.57
II	Under 13.9	17	7.0	13.0	176.0	110.9	.63	.88
	14-14.9	14	7.3	15.2	219.0	122.6	.56	.75
	15+	10	6.1	17.9	254.0	124.5	.49	.68
III	Under 13.9	11	6.0	12.4	158.0	121.7	.77	1.00
	14-14.9	10	5.9	15.0	191.0	110.8	.58	.85
	15-16.9	7	6.5	16.1	201.0	114.6	.57	.78
	17+	8	5.9	18.6	255.0	109.6	.43	.74

ties late planting again resulted in a lower yield, while, for the rest of the state, too early planting was quite as ineffective as too late planting. In Coos, Grafton, Merrimack, and Rockingham Counties, labor per acre and per bushel, and cost per bushel increased with the lateness of the planting season. In the rest of the state, lower labor cost and cost per bushel are associated with the medium planting date, both early and late planting being markedly less satisfactory.

Seed

The amount of seed used varied from as little as twelve bushels to as much as twenty-two. No influence on yield for 1927 was noticeable in the northern group, but all through the southern part of the state the amount of seed was closely associated with yield. An increase in seed resulted in an increase in yield. (Table X.) On the basis of increases in yield and decreasing costs per bushel it is probably unwise under present systems of culture to use more than 18 to 20 bushels of seed per acre. When small amounts of seed (12 to 13 bushels) were used one bushel increases in seed reduced cost per bushel 12 to 15 cents. When the larger amounts of seed (18 bushels) were used the same increases in seed reduced cost per bushel 3 to 4 cents.

The other cultural practices remained practically the same. Insofar as the limited data will permit one to judge, the influences due to other practices, such as spraying and fertilizing, certified seed, and differences in area have been reduced to a minimum, so that differences in yield are largely due to differences in the amount of seed.

Here again, in the southern part of the state, increases in amount of seed gave greater returns per dollar invested than did increases in amounts of fertilizer.

In 1926 the number of growers in the north using certified seed was too small to be tabulated. In the southern part of the state the dry weather lessened the difference that might be found, yet the ten bushels average increase more than paid for the higher seed cost at the prices prevailing for the 1926 crop. In 1927 increases of from 40 to 50 bushels recorded in all three groups much more than paid for the extra seed cost. (Table XI.)

Certified seed is also more important in the southern part of the state than in the north. Better seed gave greater returns per dollar invested than did increases in fertilizer.

Method of Applying Fertilizer

Two common methods used to fertilize the potato crop were: (a) to put all fertilizer on at planting time, and (b) to put on part at planting time and the balance before the first cultivation. Yields did not indicate that the latter practice is justifiable even when as much as 2,500 pounds were applied. This is particularly true in years of moderate amounts of rainfall. Hardenburg[3] found that under usual conditions in New York State broadcasting part of the fertilizer before planting gave some increase in yield. It is doubtful, however, if the increase in yield due to a double application is sufficient to pay for more than the additional labor.

In Coos and Grafton Counties a slight increase in yield followed the two applications method. In the rest of the state, probably because of the dry season of 1926, a materially smaller yield was obtained from the same practice. (Table XII.)

Labor costs per acre and per bushel were higher when two applications were made. Cost per bushel in the north was the same.

TABLE XI.

Influence of Source of Seed on Yield, Cost and Labor.

Area	Seed Source	Number of Farms	Area in Potatoes	Yield Per Acre	Man Labor Per Acre	Man Labor Per Bushel	Cost Per Bushel	Seed Per Acre
1926								
Other Counties	Certified	35	5.5	183.4	106.3	.58	.91	14.6
	Home	32	4.5	173.8	122.2	.70	.93	14.9
1927								
I	Certified	11	13.5	327	111.7	.34	.51	17.9
	Home	28	5.3	284	122.3	.43	.56	16.1
II	Certified	24	7.2	224	123.2	.55	.72	15.0
	Home	12	6.3	187	129.4	.69	.90	15.2
III	Certified	20	8.6	207	116.1	.56	.78	14.4
	Home	12	4.1	157	121.4	.77	1.07	14.9

Because of the smaller yield by the two applications method in the rest of the state, cost per bushel was considerably higher.

Amount of Fertilizer

The total amount of fertilizer had a much more important influence on yield than did the method of application. Yet in a very dry year increasing amounts of fertilizer may show little or no increases in yield, and the increases may barely pay for the extra fertilizer. (Table XIII.) If suitable land is limited in quantity it may be more desirable to obtain higher yields by using the larger amounts of fertilizer on the same area. If, however, suitable land is available, results would warrant using more land and putting the extra fertilizer on the increased area.

Amounts of fertilizer much above 1,500 pounds did not produce the same increases in yield for each increase in fertilizer that were obtained from amounts under 1,500 pounds.

The total amount of manure applied was considerably more than the amounts shown. (Table XIII.) Only that portion thought to be used by the crop was charged to it. It was assumed that 40, 30, 20, and 10 per cent. of the manure was received respectively by the first, second, third and fourth crops after application. On lighter soils a 50, 30 and 20 per cent. distribution was used.

Only two farms failed to use manure in Coos and Grafton Counties. These two farms did not have it to use. In the rest of the state few farms failed to use manure where it was available. One larger grower without stock attempts to replace organic matter with a green manure crop on at least part of his area.

TABLE XII.

Relation of Method of Fertilization to Yield, Labor and Costs per Acre and per Bushel. 1926-1927.

Area	Method of Application	Number of Farms	Area in Potatoes	Yield Per Acre	Fertilizer Per Acre	Seed Per Acre	Labor Per Acre	Labor Per Bushel	Cost Per Bushel
Coos and Grafton Counties	All in machine	19	9.2	289.9	1836	15.5	109.4	.38	.54
	Part in machine Part broadcast	19	9.0	292.6	1804	15.6	119.6	.41	.54
Other Counties	All in machine	44	6.3	190.1	1468	14.8	116.6	.61	.85
	Part in machine Part broadcast	42	6.1	175.6	1392	14.4	125.0	.71	.91

Increases in fertilizer in 500 pound units increased yields by 15 to 30 bushels in the north, but because of dry weather in 1926 and blight in 1927 the southern part of the state showed only a tendency toward increased yields.

Increases in the amount of fertilizer applied did not produce consistent increases in yield. In Coos and Grafton Counties an increase from 831 pounds to 1,344 pounds produced a gain of 29.0 bushels. Another increase to 1,876 pounds added only 12.0 bushels to the total yield. At a cost of $2.00 a hundred pounds of fertilizer, an additional 500 pounds must result in at least a $10.00 increase in crop value to meet the additional fertilizer expense, and a further increase of $2.50 to meet other costs including extra labor. In Coos County a 50 cent crop would require 20 bushels increase to pay for the fertilizer and 5 bushels to pay for other costs. In the southern

TABLE XIII.

Relation of Amount of Fertilizer to Manure and Other Cost Factors. 1926-1927.

Area	Amount of Fertilizer	Number of Farms	Acres Per Farm	Yield Per Acre	Labor Per Acre	Labor Per Bushel	Cost Per Bushel	Manure Per Acre	Fertilizer Per Acre
Coos and Grafton Counties	Under 1000 lbs.	21	4.4	252.5	147.2	.58	.62	7.3	831
	1001-1800	27	4.5	281.5	131.8	.47	.57	5.6	1344
	Over 1800	14	4.2	293.5	123.4	.42	.55	2.5	1876
Other Counties	Under 1000 lbs.	12	4.7	171.7	111.5	.65	.92	8.7	938
	1001-1500	26	4.2	176.1	118.5	.67	.97	4.5	1426
	1501-1800	14	5.4	186.4	113.5	.61	.97	5.3	1716
	Over 1800	13	4.3	185.2	131.8	.71	1.02	3.7	2000

TABLE XIV.

Influence of Spraying on Various Cost Factors

Area	Times Sprayed	Number of Farms	Area in Potatoes	Yield Per Acre	Spray Material Cost Per Acre	Man Hours Per Acre	Man Hours Per Bushel	Cost Per Bushel
1926								
Coos and	.....	20	8.2	246.9	.....	147.1	.60	.64
Grafton	1-2-3-	10	7.4	292.6	3.85	120.1	.41	.54
Counties	4-5-6-7-	12	9.8	296.1	5.50	110.6	.37	.52
	Dust 4.7	11	6.8	266.1	11.62	110.0	.41	.57
All other	.....	15	5.2	152.6	1.73*	143.8	.94	1.05
Counties	1-2-3-	25	5.4	166.1	7.02	124.4	.75	1.03
	4-5-6-7-	35	6.3	194.9	7.24	111.1	.58	.86
	Dust 4.5	11	13.6	179.8	11.68	85.3	.47	.82
1927								
I	-0-	21	5.6	280	.....	155.9	.57	.63
	1-2-3-	19	6.0	290	3.52	138.9	.48	.57
	4-5-6-7-	19	5.9	308	11.03	117.4	.38	.51
	Dust 3.2	11	11.9	290	12.58	112.0	.39	.54
II	-0-	10	6.8	178	4.54	126.0	.71	.83
	1-2-3-	12	5.8	208	7.62	127.0	.61	.77
	4-5-6-7-	15	8.2	259	14.27	124.0	.48	.69
	Dust 5.1	7	9.1	232	14.77	119.0	.51	.75
III	-0-	21	5.2	151	3.43	128.0	.85	.97
	1-2-3-	10	5.4	210	6.94	136.0	.65	.73
	4-5-6-7-	13	6.3	227	12.23	141.0	.62	.63
	Dust 4.7	5	11.3	215	13.68	132.0.	.61	.64

*Poison

part of the state, where potatoes are higher priced, 10 bushels increase in yield offsets increases in cost up to 500 pounds of fertilizer.

Spraying

The effects of spraying are shown in Table XIV. Even in Coos and Grafton Counties the yield of potatoes in both 1926 and 1927 was increased by 28 bushels in 1927 and by 49 bushels in 1926. In the southern part of the state yields were increased by from 42 to 76 bushels. The important factor in spraying seemed to be the thoroughness of application rather than the number of sprays, although thoroughness is indicated by number of applications and cost of materials. In a rainy season more frequent sprayings are necessary to keep the new growth covered with a protecting film of copper.

TABLE XV.

Comparison of Costs and Results of Bordeaux Mixture and a Copper Dust in Blight Control. 1926.

	Number of Farms	Area in Potatoes	Yield Per Acre	Number of Applications	Cost of Man Labor	Cost of Horse Labor	Cost of Material	Total Cost per Application	Total Cost All Applications
Bordeaux	13	12.5	212.3	5.5	$.322	$.384	$1.51	$2.52	$13.86
Dust	9	16.9	231.4	5.7	.225	.189	2.43	2.85	16.24

If costs and labor per bushel can be reduced approximately 10 cents and 12 minutes respectively by spraying, and spray material costs add only two to five cents per bushel, the expense for spray material is justified.

Dusting compares in number of applications and effectiveness to three Bordeaux sprays. It costs approximately twice as much.

Spraying in the southern part of the state appears to be one of the factors showing very favorable results.

Moderate increases in number of applications and costs gave greater returns than similar increases in fertilizer.

Dust costs more than liquid spray for the same number of applications. (Table XV.) With average methods, dusting is less effective than thorough liquid spraying, but it is more effective than no spraying at all, (frequently all sprays are omitted in Coos County) and more effective than the three sprays usually applied in the rest of the state. However, on two groups of farms using comparable control methods, dust proved as effective as the liquid spray in controlling blight in 1926 and 1927. (Table XVI.) In general on areas too small to use special potato machinery effectively, hand dusting proved very satisfactory. About 20 per cent. more dust was used than with a power duster, and man labor was more than doubled. The total cost was nearly 70 per cent. more than that of liquid spray on larger areas. Where water was insufficient in quantity, or so far from the field that hauling was an important factor, dust again proved more satisfactory. Several growers found less interference with other farm operations, notably haying, when dust was used.

Slinging the duster over the back, filling with a prepared dust, and dusting the potatoes while the dew is on the hay, was a method of control frequently resorted to even though material cost is considerably higher than Bordeaux mixture which must be applied when the plants are dry and hay is ready to haul. Too frequently the hay was hauled and the potato crop suffered.

The larger areas may use traction sprayers efficiently. When properly adjusted, and with mixing and filling equipment conviently arranged, spraying with Bordeaux mixture is less expen-

TABLE XVI.

Materials and Costs for Different Methods for Blight Control.* 1926.

Kind of Material	Method of Application	Number of Applications	Pounds Material	Cost Per Pound	Material Cost Per Acre	Man Labor Per Acre		Horse Labor Per Acre		Total Cost Less Machine
						Hours	Cost	Hours	Cost	
Bordeaux Mixture	Traction Sprayer	5	71.0	$.11†	$7.81	3.0	$1.20	6.0	$1.20	$10.21
Dust	Traction Duster	5	141.5	.09	12.74	1.88	.75	3.75	.75	14.24
Dust	Hand Duster	5	168.5	.09	15.16	6.0	2.40	....	...	17.56

*Data from three farms.
†Includes lime.

sive than dusting. Only when water must be hauled from a distance, or spraying interferes too seriously with other farm operations, is it practicable to use a traction duster. Although the labor required per acre under normal conditions is about half that for the liquid spray, the material cost is so much higher that the total acre costs make it less economic.

Labor Distribution by Operations[5]

The labor required for the various operations varies with the locality as well as with topography, soil and other factors. The man labor used in raising potatoes on the farms in the various counties in 1926 and 1927 is shown in Table XVII. The greater rainfall during the 1927 season made all operations more difficult and accounts for the heavier labor requirements per acre in 1927 than in 1926.

Machinery

Area in potatoes is probably the most important factor influencing costs. By doubling the area, beginning with 1.9 acres, 12 to 15 bushels more per acre were raised, man labor was decreased nearly 20 hours per acre, cost per acre was decreased about 12 dollars, and costs per bushel were reduced approximately 10 cents. The step from 1.9 to 3.8 acres involves the purchase and use of some potato machinery. Except in unusual circumstances, when 7.6 acres were raised all operations were done with special potato machinery. The larger area in each case reduced labor and the better methods increased yields to such a point that per acre and per bushel costs were lower even with higher machine costs.

Fitting the Soil

The usual practice in fitting is to use the disk two or three times and the spring tooth or smoothing harrow twice. With the

TABLE XVII.

Distribution of Man Labor in Hours per Acre by Operations by Counties.

1926									
Number of farms ...	64	10	29	30	11	5	7	23	10
Operation	Coos	Grafton	Merrimack	Rockingham	Belknap	Cheshire	Hillsboro	Strafford	Sullivan
Manure hauling	3.7	1.3	2.6	2.8	1.5	1.9	2.5	2.3	3.2
Seed and fert. hauling	3.4	1.3	2.6	1.5	1.9	1.7	1.5	1.9	4.0
Plowing	7.5	5.6	6.6	4.1	4.6	6.0	6.1	6.0	6.9
Fitting	7.1	3.7	6.5	3.8	3.6	6.5	6.1	5.6	7.3
Cutting	7.1	6.8	8.1	6.0	6.8	2.6	7.9	6.9	5.6
Planting	8.0	5.8	11.2	6.8	6.6	11.3	7.8	10.0	13.7
Cultivating	10.1	8.9	12.2	11.7	8.6	10.0	10.8	14.9	14.1
Spraying	2.2	3.7	7.7	4.3	2.9	6.3	3.8	9.2	7.8
Digging	56.9	40.8	49.9	41.6	41.8	63.5	46.8	45.5	58.4
Sorting	7.6	6.4	13.4	7.4	7.4	4.5	11.2	16.5	18.9
Marketing	17.7	13.2	12.7	4.5	7.5	15.6	6.9	12.3	16.9
Total	131.3	97.4	133.5	94.2	93.2	129.9	111.4	131.1	156.8
1927 Number of farms ...	69	10	25	26	8	4	4	24	6
Manure hauling	3.5	1.5	3.0	2.4	2.1	.9	2.0	2.6	7.3
Seed and fert. hauling	3.4	1.6	2.5	1.9	1.9	2.0	2.3	2.2	3.5
Plowing	8.2	6.5	7.5	5.4	8.1	7.3	5.0	6.3	8.0
Fitting	9.2	5.2	6.9	4.9	7.9	7.1	6.9	5.9	9.2
Cutting	7.4	7.9	6.3	6.4	7.8	5.4	5.1	7.7	5.7
Planting	8.7	6.9	9.3	7.3	9.3	8.8	9.5	10.1	20.8
Cultivating	12.0	9.3	12.4	13.8	12.2	7.8	9.9	12.9	11.6
Spraying	2.4	4.5	6.3	6.3	5.1	6.4	7.8	6.2	6.4
Digging	58.9	43.4	48.5	48.9	60.0	53.3	55.5	52.7	66.0
Sorting	12.1	9.4	14.9	9.3	10.1	9.6	13.7	9.0	6.6
Marketing	19.9	13.3	12.0	8.8	13.4	13.3	11.4	9.1	17.0
Total	145.9	109.6	129.6	114.5	138.0	122.9	129.3	124.9	161.8

amount of witch grass present on many farms, it has been found a benefit to omit the disk harrowing and substitute a good spring tooth harrowing. The danger of spreading witch grass over the field with the spring tooth harrow is largely exaggerated, particularly where the presence of witch grass is used as an excuse for not raising potatoes. The spring tooth harrow brings many roots to the surface where they can be killed more easily. This helps to reduce labor later in the season by reducing the number of weeds. Having the ground in better tilth makes later operations easier, and tends to increase yield. Any reduction in the amount of deep harrowing is not advisable. Simply scratching the surface is insufficient. On clean ground three spring tooth harrowings, followed by a smoothing harrow, followed immediately by the planter, have

TABLE XVIII.

Special Machinery Costs.*

	Planter	Sprayer	Digger
Value	$124.04	$115.02	$121.57
Estimated life in years	17.0	7.0	13.6
Repair cost	$ 5.05	$ 11.17	$ 8.09
Interest	6.20	5.75	6.08
Depreciation	7.30	16.43	8.94
Total cost	$ 18.55	$ 33.35	$ 23.11

*Estimates of 57 growers for the crop year 1926 on an average area of 3.7 acres.

proved sufficient. On witchy and heavy soils four spring tooth harrowings, followed by a smoothing harrow, are necessary. When more seem to be necessary it would probably be advisable to raise some other crop than potatoes.

The disk harrow was used by 78 per cent. of the farmers. It was followed by a spring tooth on 27 per cent. of the farms, and by a smoothing harrow on 62 per cent. On 22 per cent. of the farms no disk harrow was used. Of these, 74 per cent. planted on old ground or spring-plowed fields. The usual practice is to plant on sod ground.

Wherever a tractor is used for preparing the land, man labor per acre is considerably reduced. In Grafton, Rockingham and Belknap Counties the tractor was extensively used for plowing and fitting. The cost per acre was not reduced. The main benefits were in getting the work done more quickly and in taking advantage of favorable weather.

Planting and Digging

In counties where much planting and digging is done by hand the labor requirements are high. Note Coos, Cheshire and Sullivan Counties, where digging was largely done by hand, and Merrimack, Cheshire, Strafford and Sullivan Counties, where much of the planting was done by hand.

Northern Coos County suffers particularly in this regard. The lack of labor saving machinery, especially diggers, added approximately 25 hours per acre to costs. With good help scarce and high, a three day saving per acre is sufficient reason to own a digger. Only on the smaller areas is the digger cost per acre more than the extra labor. Rocks and witch grass are two excuses usually offered for hand digging. If, however, some of the more suitable land were substituted for the less suitable, much of this difficulty would be overcome. Shorter rotations would also help materially in overcoming witch grass. Until potato raising is considered of sufficient importance to warrant the attention that is given the crop on some of the farms in the southern part of the county and

TABLE XIX.

Labor Requirements and Costs Comparing Machine with Hand Planting and Digging.

Area	Method	Number of Farms	Acres Per Farm	Yield Per Acre	Labor Planting	Labor Digging	Total Labor	Per Bushel Labor	Per Bushel Cost
1926									
I	Machine	20	10.8	286.1	5.6	43.1	99.1	.35	$ .52
II		27	6.7	158.4*	7.2	43.7	100.9	.64	1.01
III		30	7.2	195.5	7.2	42.0	93.8	.48	.83
I	Hand	7	3.1	257.6	14.4	69.3	152.2	.59	.59
II		4	2.7	196.3	27.2	78.4	199.1	1.01	.96
III		11	2.2	163.1	20.9	65.2	165.7	1.02	1.08
1927									
I	Machine	23	9.8	298	6.0	44.6	115	.38	.52
II		27	7.2	216	9.1	63.1	162	.54	.75
III		25	10.3	202	6.6	47.0	116	.59	.79
I	Hand	7	2.6	274	21.0	68.2	178	.65	.64
II		2	3.0	184	29.0	73.0	201	1.09	1.03
III		4	2.2	210	25.9	68.5	180	.86	.88

*Dry weather in 1926 accounts for the low yield per acre.

in other parts of the state, farmers will be handicapped in the competition with other regions.

Special machine costs are shown in Table XVIII. These costs are: planter, $18.55; sprayer, $33.35; and digger, $23.11. If it is assumed that small differences in area do not seriously affect the life of a machine,[6] the man with a machine cost of $75.01 on 3.7 acres could raise 5 to 7 acres without increasing the total cost of machinery. The acre costs would then be reduced from $5.01 for planter, $9.01 for sprayer, and $6.25 for digger on the 3.7 acres to $3.71, $6.67 and $4.62 respectively on 5 acres; and to $1.86, $3.34, and $2.31 respectively on 10 acres. Savings in labor of 20 to 40 hours per acre are shown between machine and hand methods on the same areas, and greater increases on the larger areas. On 10 acres a total cost of $7.51 per acre for machinery is more than balanced by the saving in labor. On the basis of 40 cents per hour for labor as small an area as 3.8 acres will save enough labor to pay for planter and digger costs. (Table XIX.)

While planting and digging show the greatest advantage in labor saving in hand versus machine methods, other operations—fitting the land, cultivating, and cutting seed—showed material savings.

Cutting Seed

The practice of cutting seed by machine is rapidly gaining. Only three growers were found using cutters in 1926. In 1927 the number had increased to seven; and many other growers requested information. In yield the few farms using cutters showed better than average crops for the area in which they were located. Other practices, however, such as more fertilizer, more seed, and larger areas, had a greater influence. The greatest benefit came from the saving in labor. In hand cutting a day's work is usually 15 to 18 bushels. With a machine cutter 40 to 60 bushels are cut. This amounts to a saving of about six hours per acre. With no reduction in yield because of the practice, labor and costs per bushel are reduced by 10 to 15 minutes and 1 to 3 cents per bushel, and a large crew is unnecessary.

Cheshire and Sullivan Counties reported the lowest labor requirements for cutting seed since several of the growers used small uncut potatoes.

Planting

The majority of the old planters were of the two-man type. The larger proportion of new machines encountered in the second year of the survey were the picker type. The supposed greater accuracy of the platform type, particularly with close planting, and the expected higher yield from a more perfect stand, did not materialize.

The Geneva Station[7] has shown that the hills adjacent to a missing hill have sufficient extra plant food and room to take care of about half of the expected yield from a missing hill. With so many other factors influencing yield it is difficult to assign a loss in value to the skips resulting from a picker planter. Extra labor amounting to a day's work for every two and one-half acres, the most common rate of planting as found in the survey, is sufficient to make the use of a two man planter a questionable economic practice.

Cultivation

Cultivation may consist of several operations. The process of recovering, which is very generally practiced, is usually the first. Occasionally a smoothing harrow is used for the first cultivation after planting. It is a more efficient tool than the ridger or cultivator if used early enough to get the young weed seedlings. It is then followed by the recoverer which may be followed or occasionally preceded by the cultivator. Very little horse weeding was practiced. Practically no hand hoeing was attempted, only big weeds which might interfere with digging were cut out occasionally.

Where a ridger or horsehoe was used, hilling was accomplished with that tool. The hill is less pronounced than that made with a shovel plow. The former practice is to be recommended as

a labor saver. High ridging, or hilling, damages the roots between the rows and may affect drouth resistance.

On the poorer drained soils the present methods of planting, cultivation, and ridging or hilling are desirable. On the better drained and lighter soils, planting at a somewhat greater depth and covering the potato less deeply at the start would give quicker germination and easier weed control with much less hilling. A simple ridging would be sufficient. Digging by hand under this system would be more difficult, and machine digging would be necessary. But frequently a better crop with a larger proportion of marketable tubers would be secured.

The best cultivation is done with a riding cultivator. A two-row cultivator materially reduced the job. Six to eight acres a day were cultivated with a two horse outfit; one horse cultivation was at the rate of four to five acres a day.

Shallow cultivations, except for the first, gave more satisfactory results.

Harvesting

Where vines are kept green till digging time their disposal presents a problem. Occasionally they are cut and raked off. More frequently they are pulled by hand. When vines are partly dead, raking with a horse rake frequently removes enough to make digging faster. Horse methods of removing vines economize on man labor.

In clean land under present cultural practices two good horses on an elevator digger can handle a day's digging. On larger areas with longer, steadier traction, such diggers work more satisfactorily with three horses. If planted deeply and only light ridging is practiced the three horses would be necessary.

On still larger areas a horse-drawn power-driven elevator digger is more satisfactory. It works well on weedy land.

Picking is accomplished in various ways. On certain farms pickers were paid by the bushel. Most pickers, however, were paid by the day.

Larger yields make piece work more profitable than small yields. Therefore, much piece work is done in the north. Picking into bushel baskets and emptying into feed sacks left for the wagon or truck is the common custom. Two growers picked in baskets and emptied into a tip cart which was unloaded directly into the cellar by a chute. Much bruising accompanied this method. One grower picked into crates which were hauled to the storage and dumped. This method on the larger areas necessitates a considerable storage space for crates.

In contrast to these methods Maine growers pick in half bushel stiff handled baskets and empty into barrels which are hauled on low wagons. With care very little bruising results. Only a few New Hampshire growers use this method, but they accomplished their digging with less labor and less energy than is required with the bushel basket. The saving in time amounted to the equivalent of one man in seven.

TABLE XX.

Method and Season of Marketing Potatoes. 1927.

County	Number Selling					Percentage of crop sold from	
	At Farm Wholesale	At Farm Retail	At Car Wholesale	At City Wholesale	At City Retail	Field	Storage
Coos	.....	.....	69	.....	.....	23.6	76.4
Grafton	.....	.....	6	2	2	45.2	54.8
Merrimack	1	.....	.....	11	13	13.0	87.0
Rockingham	.....	4	.....	9	13	44.0	55.7
Belknap	1	.....	.....	1	6	43.0	57.0
Cheshire	.....	.....	.....	1	3	35.0	65.0
Hillsboro	.....	.....	.....	2	2	34.0	66.0
Strafford	.....	.....	.....	5	19	10.4	89.6
Sullivan	1	.....	.....	1	4	31.3	68.7
Totals	3	4	75	32	62	31.1	68.9

Disposal Methods

The method of disposal of the potato crop has much to do with its handling in storage. In 1926 there were three graders in Coos and Grafton Counties. In 1927 there were eight. In Merrimack and Rockingham Counties there were two in 1926 and six in 1927. In the rest of the state there were four in 1926 and six in 1927. When selling at the car door the usual practice is to haul "bin run" and to have the entire crop run over the rack at the car. Many growers, however, sort to a limited extent and save the long haul on a large quantity of seconds and culls.

Wherever disposal is direct to the retail trade or to a retailer, sorting is done at the farm. Under these conditions particularly, the better and more uniform grade made possible with a grader compared to rack sorting would warrant an investment in a grader where the other operations are on a scale large enough to warrant special potato machinery, even though there were no savings in labor. Where good sorting is done one man can rack by hand at the rate of 50 to 75 bushels a day. With a machine grader a crew of three men can grade 400 to 600 bushels a day.

Sorting is a variable factor depending on the method of harvesting and marketing, and the time of marketing.

With the disposal of the crop primarily to retail trade the necessity for some efficient means of grading is apparent. (Table XX.) With the long uphill hauls common in Coos County it would seem advisable to sort at the farm, hauling only good stock to the car and with a return load, if possible, of some needed farm supplies.

In Coos County many farmers haul the entire crop to the car. Seventy-six per cent. are sold from storage necessitating some sorting at the farm. Practically all, however, are again sorted over the rack at the car. In Grafton County grading is largely done over mechanical graders and about half of the potatoes are sold from the field. In Merrimack County sorting is done by hand before hauling to market, and 87 per cent. were sold from storage. Rockingham County growers used graders and hauled some potatoes direct to the chip factory at Salem, leaving the small potatoes in the field. But 56 per cent. were sold from storage. Belknap County growers used graders and sorted some in the field, selling 57 per cent. from storage. Cheshire County growers did most of their sorting in the field at digging time and disposed of 65 per cent. from storage. Growers in Hillsboro County sorted in storage and sold 66 per cent. from storage. Strafford County growers sorted by hand, and sold 90 per cent. from storage. Hand sorting was done in Sullivan County and 69 per cent. of the potatoes were held for winter delivery.

When potatoes are high in price it is sometimes desirable to pick more closely than when potatoes are cheap. Some of the seconds may be sold as table stock. The greater labor required, however, would usually make it uneconomic to handle small potatoes in the field, in the cellar, and on the road to the car. This would be particularly true in a low price year. This practice would also result in a more uniform community product.

Certified Seed

Because of the limited number of farms raising seed in 1926 and 1927, no detailed analysis could be made. Labor costs in the growing field were increased by two rogueings and extra care in all tillage operations. Labor was increased by 21 per cent. on two farms. At harvest time more care was exercised, and in grading nearly a quarter of the crop was discarded, (i. e.) sold for table stock, fed, or used for seed at home.

On two farms rogueing by experienced operators was done at the rate of 2 to 2½ acres a day. These farms required respectively 176 and 168 hours of man labor per acre to grow and haul to market 12.25 acres of potatoes as compared with 145.9 and 138.0 hours per acre for the average labor requirement of the two counties in which the farms were located.

Seasonal Labor Distribution

Daily labor records were kept by 12 growers. The distribution of labor by 10 day periods is shown in Figure 2. The seasons requiring large amounts of labor, planting and harvesting, are the critical periods. By a study of certain of the records it is possible to determine the organization of the potato enterprise under a variety of conditions.

As indicated in Figure 2 the two times at which labor is at a

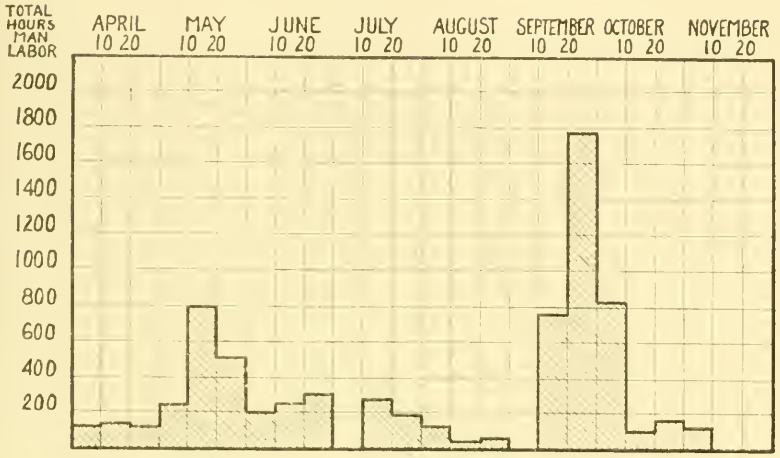

Figure 2—The distribution of labor on potatoes by 10-day periods on 12 farms raising 57 acres of potatoes.

premium are planting and harvesting. Whatever changes could be made at these periods would permit of changes in farm organization.

On the 12 farms on which labor is illustrated in Figure 2, preparation of the ground took 9.6 hours for plowing and 7.3 hours for harrowing. Cutting seed required 7.6 hours per acre, and planting 15.0 hours. The latter includes hauling, sorting and treating seed, hauling fertilizer, and marking and other operations in hand planting. Cultivating required 17.3 hours, including recovering through all the cultural operations to hilling. Spraying time was much less; only 1.7 hours per acre were used. Digging, picking up and hauling to storage required 50.0 hours.

This distribution of labor fitted in with the main dairy enterprise on most of the farms. Potato planting just preceded corn planting. In those sections where corn was raised, land was prepared and planted while the potato crop was germinating.

The harvesting of the potato crop followed silo filling on those farms where silage corn was raised. If, however, hand digging was necessary, any considerable area in potatoes would upset the farm organization.

Since so much of the profit on the farm is the pay the operator gets for his labor it would seem advisable to adjust one's organization so that advantage may be taken of the opportunity that machinery offers to obtain a higher wage. If we can raise five acres of potatoes with no greater total labor than is required for 3.5 acres and do it at no greater cost per acre or per bushel, we receive a larger return for our time and the energy expended is less.

TABLE XXI.

Number of Farms, Potato Area per Farm, Yield per Acre, Costs per Acre and per Bushel by Counties for 1926 and 1927.

County	1926					1927				
	Number of Farms	Area in Potatoes	Yield Per Acre	Total Cost Per Acre	Cost Per Bushel	Number of Farms	Area in Potatoes	Yield Per Acre	Total Cost Per Acre	Cost Per Bushel
		Acres	Bushels				Acres	Bushels		
Coos	64	4.5	293.3	$157.46	$ .54	69	5.9	294.4	$160.41	$ .54
Grafton	10	11.6	274.8	150.21	.55	10	10.6	262.5	162.14	.62
Merrimack	29	4.4	169.5	176.03	1.04	25	6.7	241.2	172.22	.71
Rockingham	30	7.4	166.5	158.76	.95	26	7.1	183.3	154.49	.84
Belknap	11	11.6	186.2	148.18	.80	8	9.8	246.2	174.87	.71
Cheshire	5	4.4	208.7	166.71	.80	4	6.8	189.5	152.45	.80
Hillsboro	7	4.7	191.6	180.44	.94	4	8.0	219.5	168.34	.77
Strafford	23	3.5	183	171.60	.94	24	5.6	148.5	154.13	1.04
Sullivan	10	2.4	240.7	192.89	.80	6	3.7	252.3	199.09	.79

TABLE XXII.

Man and Horse Hours and Cost per Acre, and Machine Hours and Cost per Acre by Counties.

County	Number of Farms	Area in Potatoes	Man Labor		Horse Labor		Equipment Cost Per Acre	Tractor Use		Truck Ton Miles		Total Labor and Machine Cost	
			Hours Per Acre	Cost	Hours Per Acre	Cost		Hours Per Acre	Cost	Per Acre	Cost	Per Acre	Per Bushel
1926		Acres											
Coos	64	4.5	131.3	$45.95	107.9	$19.22	$ 7.47	1.1	$1.36	18.5	$ 2.97	$ 76.97	$.262
Grafton ...	10	11.6	97.4	34.08	80.1	14.41	5.60	2.6	3.26	42.4	6.78	64.13	.233
Merrimack .	29	4.4	133.5	47.49	95.3	18.51	6.67	.4	.53	63.5	10.15	83.35	.492
Rockingham	30	7.4	94.3	32.96	64.2	11.56	4.50	1.4	1.73	31.6	5.05	55.80	.335
Belknap ...	11	11.6	93.2	32.62	52.0	9.35	3.64	2.9	3.67	40.4	6.46	55.74	.299
Cheshire ...	5	4.4	129.9	45.47	81.0	14.67	5.70	—	——	89.2	14.27	80.11	.384
Hillsboro ..	7	4.7	111.4	38.97	83.8	15.09	5.87	—	——	28.8	4.61	64.54	.337
Strafford ..	23	3.5	131.1	45.89	94.3	16.97	6.76	.95	1.19	46.3	7.40	78.21	.427
Sullivan ...	10	2.4	156.8	54.89	110.5	19.90	7.71	—	——	29.1	4.65	87.15	.362
1927													
Coos	69	5.9	145.9	52.27	117.6	21.13	8.44	.7	1.23	11.3	2.10	85.17	.289
Grafton ...	10	10.6	109.6	40.67	93.4	17.29	8.32	1.5	2.55	11.5	5.03	73.86	.281
Merrimack .	25	6.7	129.6	50.76	94.3	17.40	8.43	1.5	2.59	36.3	9.96	89.14	.370
Rockingham	26	7.1	114.5	42.01	83.2	15.20	7.28	1.2	2.18	28.2	5.29	71.96	.392
Belknap ...	8	9.8	138.0	51.79	93.0	17.32	10.15	3.1	5.35	24.0	5.60	90.21	.366
Cheshire ...	4	6.8	122.9	48.45	83.1	15.79	6.86	.5	.88	23.0	7.96	79.94	.422
Hillsboro ..	4	8.0	129.3	49.64	81.5	15.29	6.69	4.0	7.11	16.5	2.74	81.47	.371
Strafford ..	24	5.6	124.9	45.17	96.0	17.20	7.47	1.2	2.06	13.3	4.71	76.61	.516
Sullivan ...	6	3.7	161.8	61.68	130.7	24.40	11.24	.2	.33	11.7	5.07	102.72	.407

Conclusions

Of the several factors shown previously to have the greatest influence on the labor requirements per acre, topography and soil as natural factors and size and machinery as mechanical factors are the most important.

Some land is too steep to use machinery. Such land probably is too steep to raise potatoes even as a means of utilizing labor that would otherwise be wasted. There are also localities in which large rocks are so frequent that the economical use of an elevator digger may be questioned. On an area of less than two acres it may still be possible to raise potatoes profitably on rocky ground by using many hand methods; yields, however, must be very good. Note this farm in Sullivan County. The area is 1⅛ acres. The man labor requirement is high (216 hours) because planting, dusting and digging are done by hand. Yet even with a high acre cost ($235.96) a yield of 388 bushels per acre of marketable potatoes made possible a low bushel cost of 61 cents. On another farm using similar methods on 1.5 acres and only 163 hours of labor, the cost was $171.87 per acre. But a yield of only 112 bushels made a bushel cost of $1.53.

These farms were both too rocky to permit the use of machinery, but in one case the operator is justified in continuing to raise potatoes; the other man should discontinue the business or put it on a better basis.

On the same sort of soils, with a larger area a planter can frequently be used even though a digger would not save sufficient labor to justify its purchase and use. Two farms in Merrimack County illustrate this. One had four acres and required 177 hours of labor per acre. It was so rocky that no digger was used. With a yield of 194 bushels, costs per bushel were 98 cents. On the other farm, using both planter and digger, the labor required was 170 hours per acre, and with a yield of 295 bushels the cost was 73 cents a bushel. Little labor was saved by the use of a digger because of delays in getting around rocks; yet costs per bushel were considerably reduced by a larger yield.

If soil and topography are such as to permit the efficient use of the special potato machinery, and the size of the farm is large enough to warrant expanding the area in potatoes, greater economies in labor may be effected. A farmer in central Belknap County with six acres and machinery has been able to produce potatoes with a labor requirement of only 110 hours per acre at a cost of 55 cents per bushel on a 200 bushel yield. Another farmer in Cheshire County on six acres used 109 hours of labor to raise a 221 bushel crop at a cost of 49 cents per bushel.

Still further increases in area make possible greater labor savings and consequent lower bushel costs. In southern Grafton County a yield of 365 bushels per acre on 26 acres required but 92 hours of man labor an acre resulting in a cost of 41 cents per bushel.

Several of our larger growers show economies of production that compare with the better growers of Maine and New York in

TABLE XXIII.

Material Used and Cost per Acre by Counties.

County	Number of Farms	Area in Potatoes	Land Rent Per Acre	Manure Used		Fertilizer Used		Seed Used		Fungicide Used			Cost Per Acre	Insecticide Used						Material Cost	
				Per Acre	Cost Per Acre	Per Acre	Cost Per Acre	Per Acre	Cost Per Acre	$CuSO_4$	Dust	Other		Lead	Paris Green	White Arsenic	Dust	Other	Cost Per Acre	Per Acre	Per Bushel
1926		Acres		Tons		lbs		Bus		lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.			
Coos	64	4.5	$5.21	4.8	$10.31	1416	$31.15	15.5	$31.50	19.4	1.2	—	$1.83	2.1	.6	—	.5	—	$ .49	$ 80.49	$.274
Grafton	10	11.6	4.19	2.4	5.35	1547	32.08	15.0	34.82	80.4	36.0	—	9.03	2.2	—	.3	1.3	—	.61	86.08	.313
Merrimack	29	4.4	5.87	5.2	11.65	1458	30.31	12.2	37.21	35.6	8.9	—	5.72	10.3	1.1	—	—	.1	1.92	92.68	.546
Rockingham	30	7.4	7.02	1.1	2.50	2067	40.82	13.7	44.76	41.6	24.3	.4	6.04	9.9	.7	.5	—	—	1.82	102.96	.618
Belknap	11	11.6	8.25	0.8	1.70	1832	33.93	16.0	38.57	17.4	70.0	—	8.09	3.0	—	.8	18.8	—	1.90	92.44	.496
Cheshire	5	4.4	5.05	2.6	5.76	1766	42.58	12.2	28.50	23.4	—	7.8	4.23	1.4	—	3.3	—	—	.48	86.60	.414
Hillsboro	7	4.7	8.26	3.4	7.55	1560	35.54	15.8	57.27	47.2	18.4	—	5.15	12.4	—	—	—	—	2.19	115.90	.605
Strafford	23	3.5	6.05	3.7	8.18	1801	32.60	15.3	41.63	26.3	3.7	—	3.63	6.7	—	—	—	.6	1.30	93.39	.510
Sullivan	10	2.4	4.92	6.1	13.69	1519	37.83	14.6	40.86	59.9	—	—	5.61	11.5	—	—	8.3	—	2.83	105.74	.439
1927																					
Coos	69	5.9	5.46	4.5	10.33	1616	32.80	16.3	23.83	17.8	1.4	—	2.51	—	—	—	—	—	.31	75.24	.255
Grafton	10	10.6	6.70	2.1	4.77	1760	33.43	17.0	31.46	19.7	68.3	—	11.70	—	—	—	—	—	.22	88.28	.336
Merrimack	25	6.7	5.44	3.5	7.68	1668	30.49	15.5	29.27	41.0	17.1	—	10.07	—	—	—	—	—	.13	83.08	.344
Rockingham	26	7.1	6.96	2.5	5.82	1719	29.32	14.6	31.20	39.9	22.6	1.0	6.85	—	—	—	—	—	2.38	82.53	.450
Belknap	8	9.8	5.38	2.8	6.13	1812	37.21	15.5	28.68	16.0	45.7	3.7	6.84	—	—	—	—	—	.42	84.66	.344
Cheshire	4	6.8	5.06	1.5	3.34	1625	29.70	13.8	27.19	38.4	10.4	—	6.29	—	—	—	—	—	.93	72.51	.383
Hillsboro	4	8.0	7.96	3.2	7.10	1675	29.00	15.0	33.80	35.7	26.4	—	8.41	—	—	—	—	—	.60	86.87	.395
Strafford	24	5.6	6.04	3.8	8.32	1488	26.69	14.3	29.98	33.2	6.0	—	6.16	—	—	—	—	—	.33	77.52	.522
Sullivan	6	3.7	5.17	8.5	18.96	1567	29.62	15.2	30.20	62.4	14.5	—	10.59	—	—	—	—	—	1.84	96.37	.381

both labor required and yield per acre. Several men located in southern Coos, in Grafton and in Rockingham Counties are producing potatoes on a man labor requirement of less than 95 hours, and obtaining a yield of 300 bushels or more. Machinery, 18 to 20 bushels of good seed, plenty of plant food represented by 1,800 to 2,500 pounds of fertilizer, and excellent cultural practices are necessary to accomplish this result.

The economical control of blight depends on size of area. On farms where satisfactory control measures were practiced yields were enough larger to more than pay spraying or dusting costs. On the smaller areas of two and three acres, the time saved by using dust, the better control made possible by the ease with which the operation is performed, and the less interference with other farm operations, particularly haying, all tended to make dusting a more practicable method of control than the liquid spray.

From the standpoint of economy of labor and materials in raising potatoes and the utilization of available labor from other enterprises, which might otherwise be wasted, it seems wise to raise at least 6 to 10 acres of potatoes. In such circumstances it is possible to make efficient use of labor, to use machinery to good advantage, and to produce a crop in sufficient quantity and of such satisfactory quality as to satisfy consumer demand.

A summary from the survey of labor charges indicates that an acre of potatoes requires about 130 hours of man labor. With proper machinery this can be reduced to approximately 100 hours. When this latter amount of labor is all that is required, and yields of 200 bushels or more are obtained, costs will average about 80 cents and it will be found profitable to raise potatoes for our local markets.

In the preceding pages cost of producing potatoes has been discussed in terms of labor requirements and money costs per acre and per bushel. These results do not necessarily determine the best procedure with potatoes, but can be used to best advantage when applied as a basis for estimating the most profitable farm organization.

On many if not all farms the problem is whether or not growing potatoes will add to the annual net income. This can be roughly arrived at by estimating the additional income and the additional cash expense when potatoes are grown. Will the contemplated potato enterprise add more than enough to the general farm income to pay for the extra materials and extra hired labor?

Potatoes are grown as the main or only enterprise on but few farms. They are most commonly grown on the farm in combination with or supplementary to the dairy enterprise. The areas as shown in the survey are not large, indicating that this crop is raised primarily to supplement the main farm business and largely with labor available on the farm.

This method of raising potatoes seems the most logical one for New Hampshire growers, even though there are localities where a sufficient area may be available to make specialization on potatoes profitable. The usual practice makes possible the use of man and

horse labor at times when the other enterprises require little attention.

Raised as a supplementary crop it may often be a wise procedure to include potatoes in the farm organization even under conditions where the production costs, allowing for all labor, machinery and horse charges, would make the enterprise a doubtful one.

In many instances a considerable amount is added to the general farm income without adding greatly to the cash outlay.

A typical case of a farm in Grafton County may illustrate this situation. The operator and his son in 1926 produced 5½ acres of potatoes with a cash outlay of $536.35 for material and $70 for extra labor. A crop of 1,038 bushels was sold for $1,141.80 so that the income was increased by about $500. (Potato tools were available and the land used was not needed for roughage production.)

In 1927, the same operator increased the acreage to 9 acres at a cash outlay of $790.25 for materials and $105 for extra labor. The crop was sold for $1,900. This increased the net income by about $1,000. The increase of 3½ acres increased the income about $500 above the preceding year.

Since this acreage of potatoes just about makes use of the time available, any further increase of acreage would probably be accompanied by high costs for extra labor and perhaps losses in the dairy enterprise due to neglect at times when potatoes needed attention.

Often comparisons are made with competing regions as to cost of production. These comparisons are valuable in studying our own management problems, but it is to be remembered that as long as we are expecting to make an income on a New Hampshire farm we must work out the most profitable combination of enterprises for that particular farm and farmer, no matter what the costs are for any given enterprise in some other state. In New Hampshire for the farms surveyed the labor requirements on the average were about 15 per cent. higher than in Maine. Seed costs for similar quantities are higher. Fertilizer costs are lower because much manure is used in rotation on our dairy farms. On the other hand many New Hampshire growers have a transportation advantage over Aroostook County, Maine, of 39 cents a hundred weight. Considering this advantage in marketing, the New Hampshire growers have a more favorable position in a comparison of costs. And in addition the crop may be grown here as a supplementary enterprise to the dairy business, while in Aroostook County the farmers are not so favored.

The data as presented in this bulletin indicate many of the factors that must be considered by the individual grower. Some of the more important are soil and topography, size and machinery, type of market, probable yields with different rates of seeding and fertilizing, amounts of seed, fertilizer and manure, methods of control of diseases and insects, the amount of labor and its distribution through the year. Some or all of these factors should be considered on all farms. Their relative importance will vary with

different localities and even with different farms in the same locality. These factors should be so combined as to give the most profitable returns. One farm on a good soil may be able to utilize 2,000 pounds of fertilizer while on another 10 tons of manure with 1,500 pounds of fertilizer might be the better practice. The amount of seed will vary with cost, size, soil and fertility. These and the other factors should be considered in their relation to potatoes and to the other enterprises on the farm.

It is becoming more and more difficult to justify hand methods. Where the area is small, machinery is too expensive. Only where family labor cannot otherwise be employed, and the yields obtained are exceptionally high, may this method be recommended.

On the more efficient farms of the state there is no question that, with labor requirements and material costs comparable with those in Maine, with yields as good as is common there, and with labor and horses available when potatoes require attention, the crop can be produced to advantage here.

Summary

1. Potatoes were shipped in from outside New Hampshire in 1925 equal to the production on 1,000 acres at a yield of 300 bushels per acre.
2. A personal survey in 1926 and 1927 was made at the farms of nearly 200 potato growers throughout the state to obtain data on costs of growing potatoes, labor and material requirements, and methods. This number included practically all of the commercial growers. In addition, 12 growers kept detailed labor records on potatoes for 1927.
3. In the potato growing sections of the state the highest labor requirements per acre were found in Coos County.
4. Where potato machinery was used savings in labor of three to five days per acre were possible.
5. All special potato machinery was economically possible on areas as small as 3.8 acres.
6. Area in potatoes was one of the most important factors influencing the amount of labor required. Increases in yield as size increased were also consistent.
7. Within the limits of this survey land values have little influence on the various cost factors. Types of soil, however, are undoubtedly associated with easy cultural practices.
8. The data indicate that Coos County is producing potatoes as a side line rather than as a major enterprise. Forty-five per cent. of its very suitable land is not yet used for potatoes as compared with 20 per cent. of its fair land. On the other hand, in Rockingham County 16 and 12 per cent. respectively for the same soils are not yet used.
9. Yields did not favor applying even large amounts of fertilizer in two applications, nor do amounts much over a ton per acre seem warranted.

10. Spraying has resulted in marked increases in yield throughout the state sufficient to more than pay for material and labor costs. This was true in the dry year of 1926 as well as in the wet year of 1927.
11. A dusting schedule of approximately five applications is as effective as three liquid Bordeaux sprays in blight control, but the costs are about double for materials, and the saving in labor is unlikely to offset all this cost.
12. Amount of seed per acre was more important than amount of fertilizer and manure applied within the ranges enumerated.
13. Certified seed showed increases of 10 to 50 bushels per acre over ordinary seed.
14. Labor per acre was much less on those farms where the rotation was short.
15. Early planting in Coos, Grafton, Merrimack and Rockingham Counties required less labor per acre and per bushel, and yields were higher resulting in lower costs per bushel than late planting. In the other counties mid-season planting gave larger yields and cheaper costs.
16. The machine seed cutters were used satisfactorily with no measurable influence toward greater or smaller yield. Nearly three times as much cutting could be accomplished.
17. Picker or one-man planters gave as satisfactory results in yield as the platform or two-man planters, planting as close as is common in the state. The saving in labor is an important factor.
18. The ability to produce as efficiently as competing areas, the nearness to markets and the deficient production within the state open opportunities for many New Hampshire growers to produce potatoes profitably.

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